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Editor: PJ Stephenson

Message from the Chair

Galen Rathbun

Chair, IUCN/SSC Afrotheria Specialist Group

Another year has slipped by since our last newsletter (Number 3, April 2005), when we were completing the Global Mammal Assessments (GMA). Many thanks to all our members for your dedication and help in getting that major project done. The GMA included IUCN Red List updates for our afrotheres, and I have been in contact with both the GMA people and the Red List Office folks about getting these updates incorporated into the 2006 Red List update. When completed, this will result in several of our species changing status - both up and down. Now we need to update the taxonomy and status matrix on our web site.

The big event since our last newsletter is the beginning of the new IUCN quadrennial, which is associated with the dissolution and re-formation of specialist groups. This process gives IUCN an opportunity to restructure specialist groups, appoint new chairs if needed, and update group membership. For example, IUCN dissolved

the Insectivore Specialist Group, which spawned The Afrotheria Specialist Group several years ago. I suspect that the message here is that we need to remain relevant and active to survive (kind of like natural selection). In any case, I agreed to continue as Chair and the past Section Co-ordinators and virtually all Members have agreed to carry on as well. We added three new members: I do not think Professor Jonathan Kingdon needs any introduction! Dr. Thomas Lehmann from the Transvaal Museum joined us as an authority on aardvarks and Dr. Andrew Baker of the Philadelphia Zoo agreed to give us his expertise on captive afrotheres, especially sengis and aardvarks (see issue No. 3 of our newsletter). WELCOME to these new members! The complete membership list is attached at the end of the newsletter.

As this issue of *Afrotherian Conservation* goes to press, we are waiting for news as to whether Jon Benstead, Link Olson, Daniel Rakotoniravony, and Erika Ranoarivony will be successful in obtaining a Chicago Board of Trade grant, through the Chicago Zoological Society, for their proposal on the web-footed tenrec in Madagascar.

With the GMA, Red List update, and new quadrennial behind us we have two main activities that need our focus. First, our web site needs attention, including finishing the golden mole and tenrec pages, and updating the taxonomy, Red List status, and membership pages. Secondly, we need to produce a conservation strategy for our threatened afrotheres. I will be contacting the Section Co-ordinators to develop a plan for accomplishing this. In the meantime, I wish all our readers a peaceful and productive year.

G.B. Rathbun

Cambria, California. 16 March 2005

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Dobson's shrew tenrec (*Microgale dobsoni*). The Tenrecidae is the most speciose taxon in the Afrotheria - some 30 species are currently recognised.

Article:

Notes on the ecology of the short-snouted sengi (*Elephantulus brachyrhynchus*) at a game ranch in North-west Province, South Africa.

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Introduction

The majority of sengis in southern Africa belong to the genus *Elephantulus*, with the most numerous and widely distributed being the short-snouted sengi (*Elephantulus brachyrhynchus*) (Nicoll & Rathbun 1990) which has a range extending from Tanzania to South Africa (Smithers *et al.* 2005, Nicoll & Rathbun 1990). In Tanzania, a habitat preference for transitional *Combretum* savannah has been shown by this species (Leirs *et al.* 1995) and, in Zimbabwe, areas with dense grass cover and scattered woodland such as miombo are preferred (Linzey & Kesner 1997, Neal 1995, Smithers *et al.* 2005). This indicates that cover and vegetative structure are important habitat requirements for the species (Rankin 1965).

Reproduction in the short-snouted sengi occurs throughout the year, but less so in the cool dry season (Neal 1995). They are thought to be monogamous, producing 5 or 6 litters per year of one or two precocial young, and therefore the reproductive system of this species is unusual for a small mammal (Neal 1995). They are thought to be territorial with males and females defending overlapping territories from individuals of the same sex (Leirs *et al.* 1995, Neal 1995).

To date, no studies have investigated the ecology of the short-snouted sengi in South Africa, which is at the southern most part of its distribution. The aims of this study were to investigate habitat preferences, density, and diet of *E. brachyrhynchus*, and to determine predation pressure on this species by barn owls (*Tyto alba*).



© R.W. Yarnell

Short-snouted sengi (*Elephantulus brachyrhynchus*)

Methods

The study took place at Mankwe Wildlife Reserve (MWR), North-west Province, South Africa (Fig. 1). MWR covers an area of 4,760 ha of relatively flat ground to the east of the Pilanesberg massif (25° 15'S, 27° 17'E), NNW of Johannesburg. The climate is sub-arid, with annual rainfall about 650 mm, mostly falling in the summer, and the mean daily temperature ranges from around 11° C in July to around 23° C in December, with extremes ranging from -6° C to 40° C.

Sherman live traps (23cm x 9cm x 7.5cm, H.B. Sherman Traps Inc., Orlando, Florida) were used to trap small mammals, laid out in a 5x5 grid formation, one trap per station, with trapping stations at 10 m intervals. Four replicate grids were selected randomly in four grassland habitats, and one open woodland area, that used to be a sisal plantation (hereafter termed 'sisal' area). Each area was trapped every four months for two years. All trapping grids were operated for five nights. Sherman traps were baited every evening with a mix of oats and peanut butter and checked every morning. Any small mammals caught were identified, aged, sexed, and morphometric data recorded. Individuals were marked with a unique semi-permanent fur clip for future identification and released at the point of capture (Gunnell & Flowerdew 1990).



Figure 1: Map of southern Africa showing the location of Mankwe Wildlife Reserve, South Africa.

Scat samples were taken for diet analysis in February 2004, and one sengi was found dead in a trap and its stomach was removed and contents analysed (Lewis 2005). Scats were collected from the Sherman traps from the first capture event. This ensured that the bait in the traps was not recorded in the diet. The scats of nine sengis were analysed under a microscope and percentage composition of insects, vegetation and seeds was estimated (e.g. Kerley *et al.* 1990).

A barn owl (*Tyto alba*) roost was discovered at MWR and pellets were collected monthly for 12 months between July 2003 and July 2004. The pellets were used to gain insights into barn owl diet by identifying any small

mammal skulls found (e.g. Avery *et al.* 2002, Bond *et al.* 2004, Riley 2005).

Results

A total of 76 individual *E. brachyrhynchus* was caught in the five study areas, across all seasons from 12,500 trap nights, with the majority (87%) being caught in the sisal habitat (Fig. 2). *Elephantulus brachyrhynchus* was only caught in two out of the four grassland areas and in two out of five seasons, whereas they were caught in all sisal grids in each season. Densities were highest in winter of both years. The spring 2003 data were omitted from Fig. 2 because fires occurred before the trapping season, which had an influence on capture rates (Yarnell 2005, Yarnell *et al.* in prep). The sex ratio was near parity (1.2:1), with 41 males and 35 females being caught.

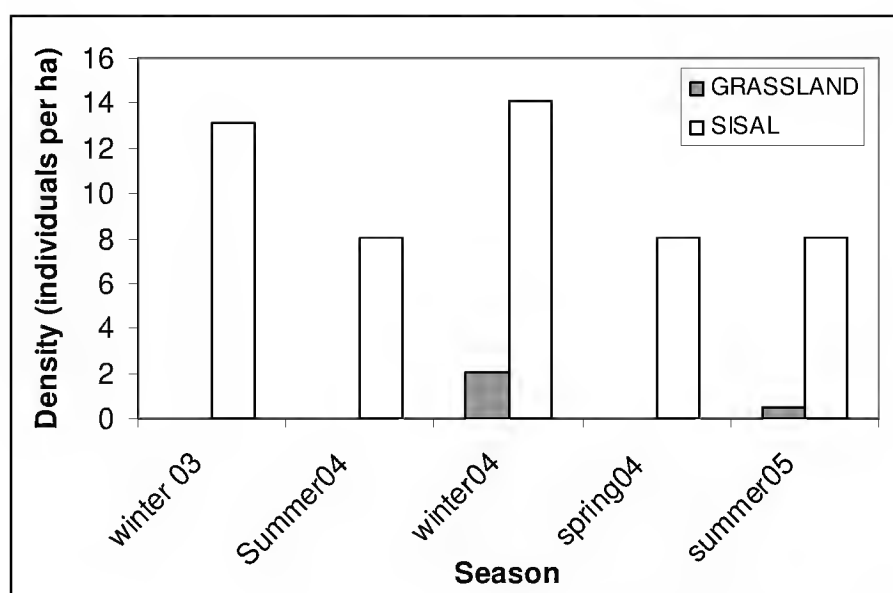


Figure 2: Mean density of short-snouted sengis in two habitats in each season. Means taken from four grassland sites (16 trapping grids) and one sisal site (four trapping grids).

Measurement	Males			Females		
	Mean	n	Range	Mean	n	Range
HB (mm)	99	49	86-115	99	36	88-114
TL (mm)	80	49	66-93	78	35	57-87
HF (mm)	26	49	24-36	26	36	16-31
Mass (g)	43	49	26-56	43	35	33-63

Table 1: Mean measurements of adult male and non-pregnant female *Elephantulus brachyrhynchus* caught at Mankwe Wildlife Reserve. HB = head & body length; TL = tail length; HF = hindfoot length.

The morphometric data collected for live trapped adult male and female *E. brachyrhynchus* are presented in Table 1. Both sexes showed similar mean measurements indicating a lack of sexual dimorphism in this species.

Scat and stomach analysis from the population at MWR showed that the diet was made up largely of vegetable matter and insects. The scats showed 37% insect, 60% vegetable and 3% seed content. The stomach contents were similar with 40% insect material and 60% vegetable matter (Lewis 2005).

No *E. brachyrhynchus* skulls were found in the 204 barn owl pellets collected at MWR (Riley 2005). The contents of the barn owl pellets consisted of 371 individual small mammal specimens which were dominated

by the most abundant rodent species caught at MWR. These were the fat mouse (*Steatomys pratensis* 34%) and the multimammate mouse (*Mastomys coucha* 27%).

Only three juvenile sengis were caught during the survey, and these were all caught in the austral summer between September and February. Two of these were born in a Sherman trap and weighed 9 g each. Both were very precocial, with eyes open, and body fully covered in fur. Seven sub-adults were caught, and all but one was caught in summer.

Discussion

Elephantulus brachyrhynchus were found in much higher densities in the sisal habitat than in the grasslands. However, only two habitats were sampled in this study and it is likely that *E. brachyrhynchus* will prefer habitats that have a higher density of trees, and are likely to be absent from grasslands with low cover or more open habitats. The sisal habitat is made up of sickle bush (*Dichrostachys cinerea*) and sisal (*Agave rigida*) thickets, surrounded by very dense and tall grassland dominated by spear grass (*Heteropogon contortus*), red autumn grass (*Schizachyrium jeffreysii*), natal red top (*Melinis repens*), three-awn grass (*Aristida congesta*) and thatching grass (*Hyperthelia dissoluta*). By contrast the densities of sengis in the grasslands were very low, and individuals were absent in the majority of seasons, suggesting that some form of tree cover, or in this case sisal thickets, are required by short-snouted sengis. Those individuals that were caught in the grasslands were often caught in areas adjacent to tree clumps or termite mounds. Therefore, it is likely that large areas of grassland that have little tree or shrub cover are unsuitable for *E. brachyrhynchus*. However, with an increase in tree and shrub density, the habitat will become more suitable for the species. Similar habitat preferences have also been noted by other authors (Leirs *et al.* 1995, Linzey & Kesner 1997, Rankin 1965). Throughout their geographic range, therefore, short-snouted sengis appear to prefer habitats that have dense grassland with scrub and scattered trees (Smithers *et al.* 2005). However, it is not known whether *E. brachyrhynchus* is found in heavily bush-encroached areas, where the tree canopy is closed and the grass layer underneath is absent. If this species requires some form of grass cover amongst open woodland, then increased bush encroachment, caused by overgrazing and a suppression of natural fires (Hudak 1999), may be restricting the availability of habitat for this species.

The densities of *E. brachyrhynchus* recorded in this study are much higher than those recorded by Linzey and Kesner (1997) who reported low densities in Zimbabwe (0.2-0.4 per hectare). Both this study and Linzey and Kesner (1997) found that densities peaked in the cool dry season (winter) each year, which coincides with the end in the peak breeding season. The higher densities observed in the dry season reflect higher levels of reproduction during the warm wet seasons (Neal 1995), which would have increased in recruitment into the adult population during the dry season (winter).

Short-snouted sengis at MWR took a high proportion of vegetable matter in their diet, with insects making up the remainder. This is similar to the diet recorded by Leirs *et al.* (1995) in Tanzania, and by Kern (1981) in South Africa. By contrast, Neil (1995) found that insects made up over 90% of *E. brachyrhynchus* diet in

Zimbabwe. Therefore, there is considerable geographic variation in the diet of *E. brachyrhynchus* and this may be related to availability of preferred prey types both temporally and geographically.

The reproductive data gained in this study are similar to that reported by Neal (1995) and Leirs *et al.* (1995), with peaks in reproduction in the warm wet season. Both Neal and Leirs found evidence for reproduction throughout the rest of the year, but at lower levels. The one birth event recorded in this study confirmed that *E. brachyrhynchus* produces one or two precocial young, weighing about 8-9 g, which is in accordance with other studies (Leirs *et al.* 1995, Neal 1995, Rankin 1965). In this study there was little evidence for reproduction in the cool dry season and it is possible that more southerly populations of *E. brachyrhynchus* have a more seasonal breeding pattern than populations at lower latitudes where temperature fluctuations are much smaller (Neal 1995). However, a more detailed study on the reproduction of *E. brachyrhynchus* in South Africa is required to confirm Neal's (1995) hypothesis.

No sengi skulls were found in the barn owl pellets. Barn owls are generally thought to forage in open grassland habitats and to be opportunistic foragers taking the most abundant prey items in any given area (Bond *et al.* 2004, Riley 2005). The short-snouted sengis prefer more wooded habitats and were only found in very low densities in the grasslands, which surrounded the barn owl roost in this study. Consequently, the behaviour and habitat preference of the barn owls studied at MWR meant that they were unlikely to have encountered short-snouted sengis as often as they would have done if they were roosting near to an area of high sengi density (e.g. the sisal habitat).

Elephantulus species have previously been recorded in barn owl pellets at other sites, but in low proportions (<2%) (e.g. Avery *et al.* 2004). Such low incidence of sengis in barn owl pellets may also be a consequence of their "sit and wait" behaviour, whereby they dash across open areas and sit motionless in areas of cover (Apps 2000). Such behaviour means that sengis are not constantly moving around their home ranges during periods of activity as many rodents do. This may make them harder for barn owls to detect than rodents and therefore *Elephantulus* may be under represented in owl diets. Therefore, the distant location of the barn owl roost and the low density of sengis in the grasslands in this study, means that the impacts of barn owls on the short-snouted sengis is probably inconsequential.

There is a lack of information on the impact of predators on sengis, and the potential roles that predators play on sengi populations and behavioural ecology is largely unknown. It is possible that other predators, such as snakes or small carnivores, will have a greater impact than owls on sengi densities, but this remains to be studied.

In conclusion, these ecological notes for *E. brachyrhynchus* confirm many of the findings from other studies on diet and habitat use. However, large gaps still remain in our knowledge regarding survival, home-range size, and social organisation, and how sengis respond to disturbances such as fire and habitat change (Nicoll & Rathbun 1990). Future studies on *E. brachyrhynchus* should concentrate on these aspects of their ecology to ensure a more thorough understanding of their status and habitat requirements.

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Article:

Radio-tracking Namib Desert golden moles

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The Namib Desert golden mole (*Eremitalpa granti namibensis*) weighs about 25 g and occupies the vast dune seas of the Namib Desert in Namibia. These golden moles hunt down invertebrate prey while travelling on the surface of the dunes mostly at night, but also while swimming through the loose sand below the surface – thus our name for them: “dune sharks.” Their distinct spoor has been used to visually track their movements. However, individual recognition is not possible using spoor, so in 2005 we spent a month in the NamibRand Nature Reserve developing a radio tag. We are currently in the process of submitting a manuscript to a journal that describes our results, but in the meantime we present here some photographs illustrating how we radio-tagged the “dune sharks”.

Our tagged *Eremitalpa* appeared to be oblivious to their man-made tails; the very thin and flexible antennas never became entangled. The transmitters remained attached for at least seven days and up to 21 days, when they were removed or shed without harming the animals. With this successful method of attaching radio tags, detailed studies of the spatial and temporal ecology of individually identifiable Namib Desert golden moles are now possible.



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Plate 1: No respectable free-ranging *Eremitalpa* would allow itself to be photographed like this captive. Note the absence of ears and eyes on the animal.



© G.B. Rathbun

Plate 2: Spoor of a Namib Desert Golden Mole going from sand swimming to surface walking and back to swimming.



© G.B. Rathbun

Plate 3: Radio transmitter built especially for us by Blackburn Transmitters (Nacogdoches, Texas 75961). They measured 12 x 5 x 4 mm and weighed 0.3 g. The 7.0 cm-long whip antenna is made of nylon-coated stainless steel fishing leader wire (7x7 Surflon Micro Supreme 20 lb. test). To maximize transmitter life (nearly 30 days), we used a three second pulse interval.



© G.B. Rathbun

Plate 4: Successful radio-tracking is dependent on having a transmitter attachment method that works. We coated a transmitter with cyanoacrylate adhesive (Devcon ZipGrip HV2200, product #44225) and then pushed the radio into the fur on the apex of the rump (*Eremitalpa* is tail-less) when the animals were torpid. When the transmitter was seated against the rump, we immediately pressed the surrounding fur firmly against the radio.



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Plate 5: We kept newly tagged golden moles in a dark bucket for about 15 minutes before releasing them. It takes a dune shark about three seconds to disappear into the sand!

Article:

Biodiversity of the Tubulidentata over geological time

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The aardvark - *Orycteropus afer* (Pallas, 1766) – is the only known representative of its kind, the last living member of the order Tubulidentata Huxley 1872 (Class Mammalia Linnaeus, 1758; family Orycteropodidae Gray, 1821). Several fossil aardvarks have been found but it must be a relief for palaeontologists to have at least one living example of this unusual mammalian order, comprising of an animal with the body of a pig, the head of a kangaroo, the ears of a rabbit, and the tail of a giant rat.



© T. Lehmann

Male Aardvark (named "Elvis") from Frankfurt Zoo, Germany. The animal's ear length is 215 mm.

The aardvark is a nocturnal mammal that spends the day in deep burrows. Aardvarks are very efficient diggers that can disappear underground in a very short time. Such skill is very useful for opening ant nests and termite mounds in order to prey upon those social insects which represent almost the entire diet of the aardvark. The anatomy of *O. afer* has been relatively well documented, in particular through the three part monograph supervised by Sonntag (Sonntag 1925, Sonntag & Woolard 1925, Clark & Sonntag 1926). The peculiar teeth of the aardvark lack enamel and consist of tubes of dentine joined together by cementum; this tubulidentate structure gave its name to the order. Little is known about its ethology, intra-specific and sexual variability, the origin of the peculiar tubulidentate microstructure of its teeth, and other details of its biology. For instance, a very intriguing question still to be answered is the validity of the 18 sub-species described so far (see Shoshani *et al.* 1988), especially as the number of individuals and the distribution of the populations are not well known. Figure 1 shows the

assumed spatial distribution of aardvark sub-species based on the data provided in their initial descriptions. It is difficult to explain how a species of large mammal like this could show such polymorphism, especially in a restricted region (like Kenya-Tanzania). Therefore, the distinction of some of the sub-species is certainly not well grounded.

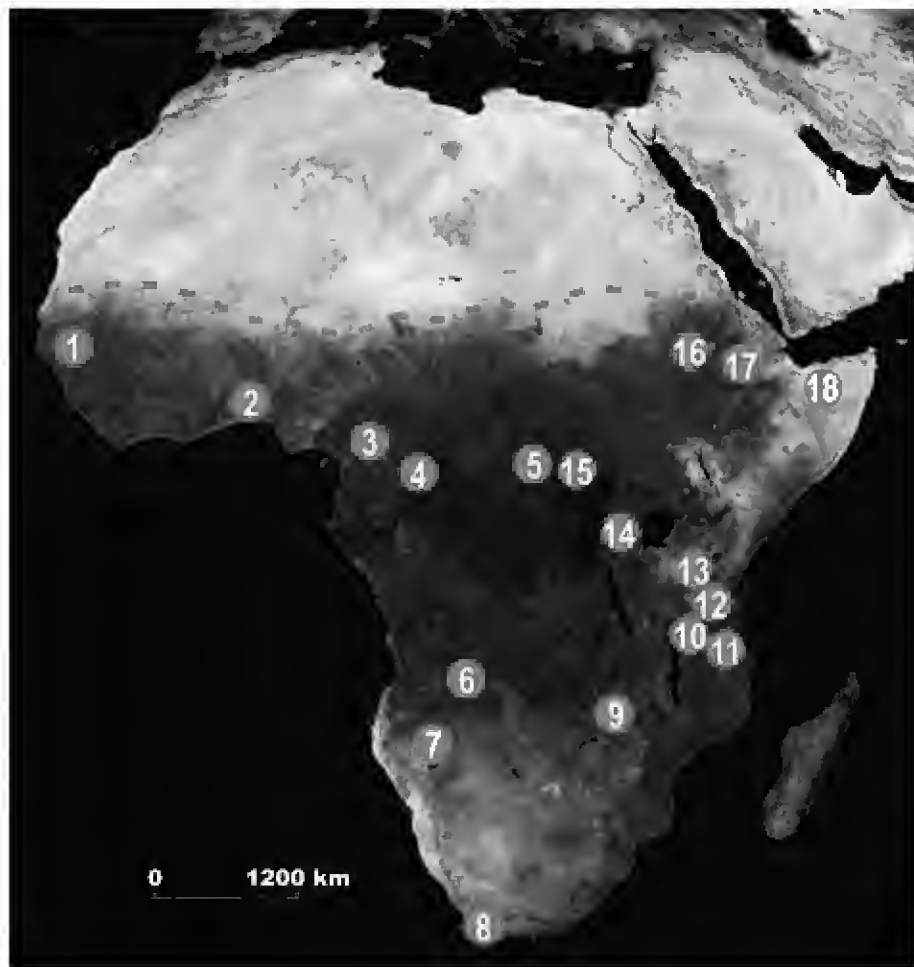


Figure 1: Assumed spatial distribution of the sub-species of *Orycteropus afer*. The dashed line represents the limits of the supposed repartition area of the species.

1. *O. a. senegalensis*; 2. *O. a. haussanus*; 3. *O. a. adametzi*; 4. *O. a. leptodon*; 5. *O. a. erikssoni*; 6. *O. a. albicaudus*; 7. *O. a. angolensis*; 8. *O. a. afer*; 9. *O. a. wardi*; 10. *O. a. observandus*; 11. *O. a. matschiei*; 12. *O. a. wertheri*; 13. *O. a. lademanni*; 14. *O. a. ruvanensis*; 15. *O. a. faradjius*; 16. *O. a. kordofanicus*; 17. *O. a. aethiopicus*; 18. *O. a. somalicus*.

The fossil record extends the geographical distribution of the Tubulidentata from Africa, to Europe, and to Asia (Fig. 2). However, the fossil material is rare and consists usually of fragmentary remains.

Lower Miocene

The first record of a fossil aardvark is from the Lower Miocene (20.5 to 16 millions years ago) deposits of Kenya. Two species are known from that period of time in Kenya.

The first one is *Orycteropus minutus* Pickford, 1975, a very tiny species of aardvark (approximately half the size of the extant species), which displays the very diagnostic tubulidentate teeth. This species has been found in only one site so far (Songhor). There are no indications from the remains that this animal was not a fossorial and myrmecophagous (ant and termite eating) mammal.

The second species, *Myorycteropus africanus* MacInnes, 1956, is originally known by a partial juvenile skeleton from Rusinga Island. Other Kenyan sites, like Kathwanga and Mfwanganu, and also perhaps a Namibian site (Arrisdriфт), yield fossils belonging to this taxon (see Pickford 1975, 2003). *M. africanus* is a small aardvark species like *O. minutus* so Made (2003) suggested they might belong to the same genus. According to the available remains, *M. africanus* also possessed tubulidentate

teeth and was a very good digger, even more specialised than the extant *O. afer*. For instance, the breadth of the distal epiphysis of its humerus (where muscles involved in the digging process are attached) is proportionally wider than in all other Tubulidentata. This taxon is thus unlikely to be the stem group of all other Tubulidentata, but is rather a sister taxon as suggested by MacInnes (1956) and Patterson (1975).

Lower Miocene fossiliferous sites are not very common in Africa, so it is not surprising that only four or five sites yield remains of tubulidentates. However, these discoveries show that the aardvarks were already widespread over Africa at that time, from the northeast to the south. Moreover, as those taxa are not involved in the ancestry of the other Tubulidentata, there must be other fossil aardvarks, yet unknown, that lived in Africa during the Lower Miocene. Finally, the presence of fully developed tubulidentate teeth suggests that this structure appeared prior to Lower Miocene, perhaps during the Paleogene. Therefore, Tubulidentata species are most probably still to be found in earlier deposits. This observation is consistent with the assumption that the radiation of Eutherian mammals in general, and the Afrotheria in particular, happened around the Cretaceous-Tertiary boundary (Huchon *et al.* 2002, Asher *et al.* 2005).

Middle Miocene

Orycteropus chemeldoi Pickford, 1975 is the only known species of Tubulidentata that lived in Africa during the Middle Miocene (16 to 11.6 million years ago). This species has been found in Kenyan sites (Tugen Hills) and is known by only fragmentary remains. Moreover, some unidentified tubulidentate fossils have been discovered in Namibia (see Pickford, 2003). *O. chemeldoi* shows unique features among Tubulidentata - very slender teeth - but it is nonetheless a typical aardvark. The presence of Tubulidentata in Africa, from east to south, is unequivocal but the actual number of species might be underestimated.

The first Eurasian aardvarks are not known until the Middle Miocene. They have been discovered in Paşalar, Çandır, and İnönü (Turkey), three sites dated between 15 and 12 million years. The specimens from Paşalar are undetermined at the species level (Fortelius 1990), but the Çandır and İnönü aardvarks belong to the species *O. seni* Tekkaya, 1993 (see Made, 2003). Only fragmentary remains are known for this species, which makes it very difficult to determine its relationships with other Tubulidentata.

Orycteropus browni Colbert, 1933 and some undetermined specimens are present in the Siwaliks (Pakistan) from Middle to Upper Miocene according to Pickford (1978), though this author synonymised another species - *O. pilgrimi* Colbert, 1933 - with the former one. *O. browni* is a small to medium Tubulidentata, which shows affinities with more recent forms like *O. gaudryi* Major, 1888 from Greece and Turkey.

The fauna associated with the Turkish Tubulidentata is related to African fauna and embodies the second most important dispersion event from Africa to Eurasia of the Miocene. It is thus highly probable that Orycteropodidae took part to this procession of African invaders and colonised Eurasia during Middle Miocene. Vrba (1996) suggests that mammalian species adapted to warm climates (like the Afrotherian, and the Tubulidentata in particular) had only brief opportunities to reach northern land masses. They need the con-

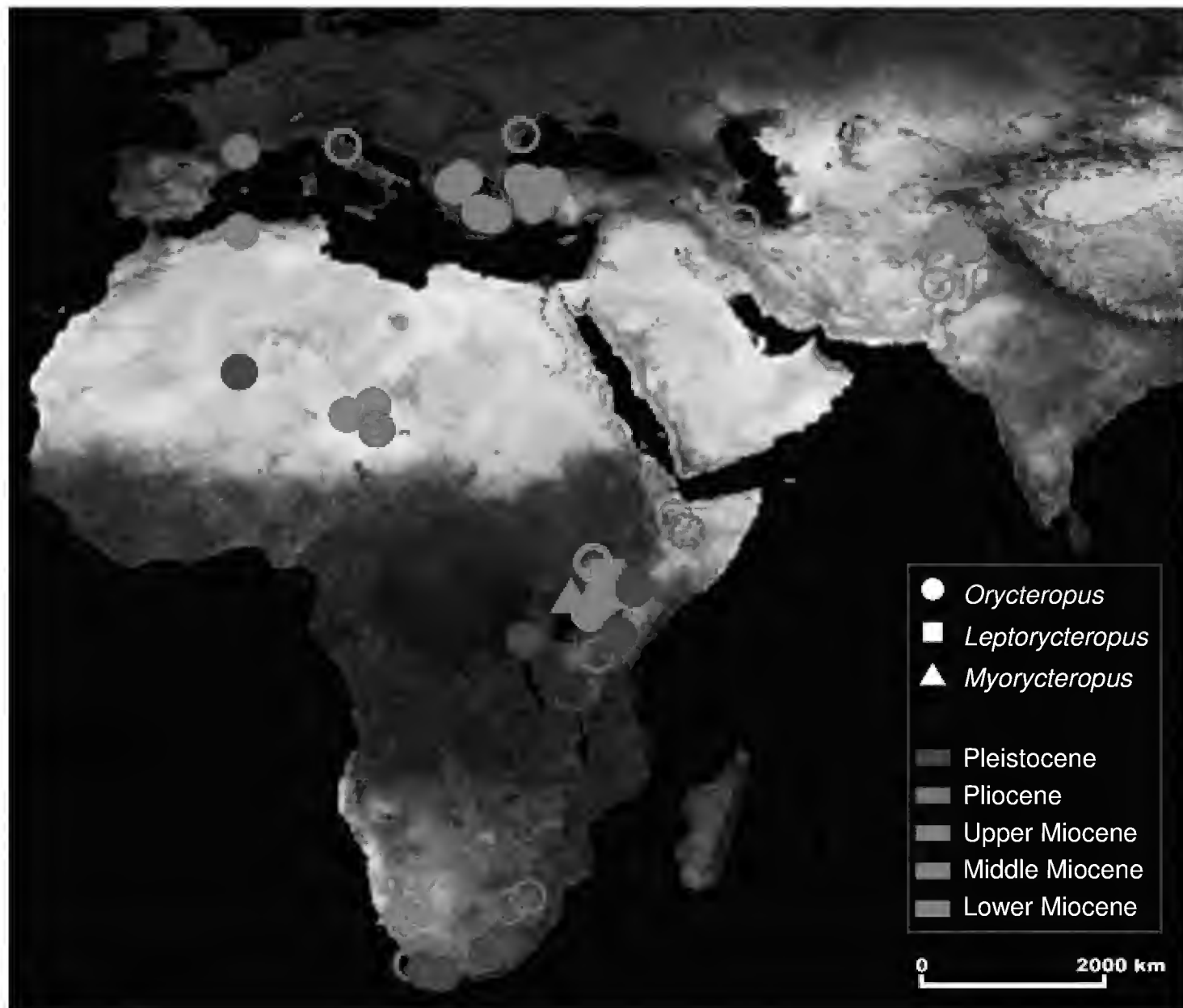


Figure 2: Spatio-temporal distribution of fossil Tubulidentata. The hollowed figures represent specimens undetermined at the species level.

junction of two conditions to do so. First, there must be a land bridge which enables the crossing between land masses. Second, the environment of the northern countries must be warm enough for the species. However, rises in global temperature generally involve the melting of the polar icecaps so that a marine transgression takes place and rapidly covers the land bridge.

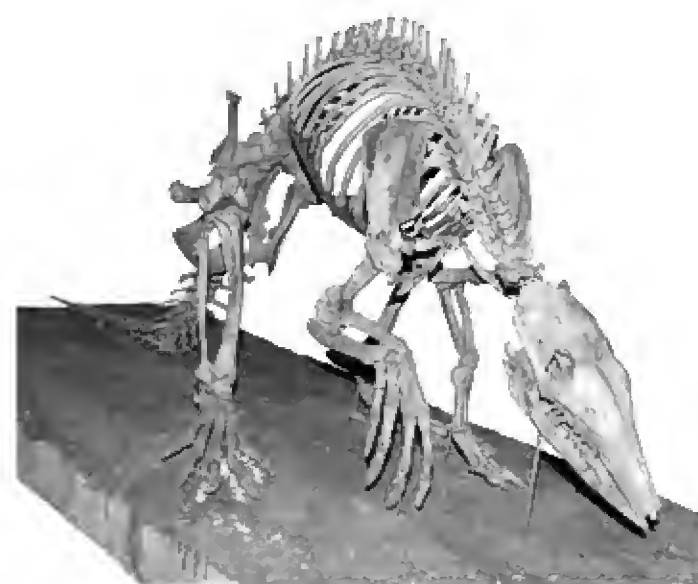
Upper Micoene

The Upper Miocene (11.6 to 5.3 million years) is the period during which the diversity and the spatial distribution of the Tubulidentata is the largest (Fig. 2). In Turkey, *O. pottieri* Ozansoy, 1965 seems to replace *O. seni* around 11 million years. However, there are no characteristics to support a close relationship between both taxa. *O. pottieri* is well known from the Sinap formation (Fortelius *et al.* 2003) and the Greek site Pentalophos (Bonis *et al.* 1994) by cranial and postcranial remains. It is a medium sized aardvark, which shows characteristics shared by Eurasian taxa (like *O. gaudryi*) and others shared by more recent African forms (like *O. afer*). Noticeably, large canines are still present in *O. pottieri*, whereas in the extant aardvark incisors and canines have disappeared.

Orycteropus gaudryi, found mainly in the Turolian deposits of the island of Samos (Greece), is historically the first fossil aardvark ever discovered (Major 1888, Colbert 1941). It is also the best-known fossil aardvark as its remains are numerous and consist of several crania, mandibles and sufficient postcranial elements to reconstruct a composite mounted skeleton (Fig. 3). *O. gaudryi* is known from Greece and Turkey but related specimens have been found in Italy, Moldavia, and Iran (see Lehmann *et al.* 2005). This form is a medium-sized

aardvark (75% of the size of *O. afer*) with a relatively short snout and slender limb bones. It was clearly a capable digger and probably already ate ants and termites.

After *O. chemeldoi* from East Africa, the next record of fossil Tubulidentata on the continent is *O. mauritanicus* Arambourg, 1959 from the Upper Miocene of North Africa (Bou Hanifia, Algeria). This species has affinities with the younger *O. gaudryi* but is larger, proving therefore that the increase in size over time is not an evolutionary trend common to all Tubulidentata lineages (*contra* Pickford, 1975). Unfortunately, the hypodigm consists only of fragmentary remains and no new discoveries have been made since.



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Figure 3: Composite reconstruction of *O. gaudryi* housed at the American Museum of Natural History, New York.

Recently, the first fossil aardvarks from central Africa have been discovered in Chad. One of those fossils is a new species – *O. abundulafus* Lehmann *et al.*, 2005 – which

lived during the late Upper Miocene and seems to have been isolated in Chad. This form looks like the penecontemporaneous *O. gaudryi* and shows a close relationship to that species, as demonstrated by Lehmann *et al.* (2005). However, *O. abundulafus* is unique among Tubulidentata for the broad size of its teeth and the probable strong *Mm. pterygoideus*, which suggest that it ate a tougher diet (like scarabid beetles). Moreover, this Chadian aardvark was a less efficient digger than other Tubulidentata because its humerus, cubitus, and hand show reduced insertion surfaces for muscle involved in the digging process, and are less robust on the whole.

Finally for that period, Patterson (1975) described a new genus based on a partial skeleton found in Kenya (Lothagam): *Leptorycteropus guilielmi*. Patterson considers this medium-sized form to be a generalised Tubulidentata; the skull and forelimb reveal no adaptations for myrmecophagy or enhanced digging habits respectively (Fig. 4). However, the known remains and the new discoveries make it difficult to confirm this hypothesis. Pickford (1975, 2004) regards *Leptorycteropus*, but also *Myorycteropus*, as synonyms of the genus *Orycteropus*. However, like Patterson (1978), and as shown by Lehmann *et al.* (2005), I consider that the differences in structure and proportion of those forms justify their distinction at the genus level.

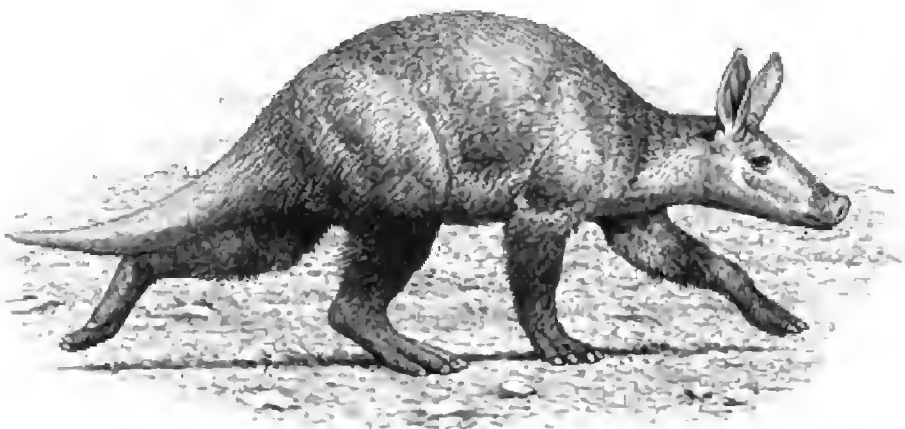


Figure 4: Restoration of *Leptorycteropus guilielmi* by Mauricio Anton. Shoulder height = 24 cm. Modified after Milledge (2003).

Noticeably, during the Upper Miocene the chronological succession of Tubulidentata is continuous for Eurasian species, whereas a gap in the fossil record is observed in Africa, between 10 and 8 million years. This gap may be artificial, due to the small number of African sites dated from that period. On the other hand, the gap could indicate a massive dispersion of Tubulidentata into Eurasia. Those species might thus have evolved on that continent before returning in Africa to give rise to new species.

The circum-Mediterranean forms of Tubulidentata seem to be related but still show important differences in features. The diversity of Tubulidentata (in number of species and in adaptations) for this period is thus remarkable. Correlatively, signs of desert environments are found in central Africa (Vignaud *et al.*, 2002) and the Messinian Salinity Crisis affected the Mediterranean Sea during the late Upper Miocene (see Dugen *et al.* 2003). Thus, it is possible that dramatic environmental changes might have triggered this high species diversity.

Pliocene

The Pliocene (5.3 to 1.8 million years) is characterized by

the disappearance of the Eurasian Tubulidentata and the emergence of modern aardvarks, closely related to the extant *O. afer* (see Lehmann *et al.*, 2004). The last Eurasian species known so far is *O. depereti* Helbing, 1933 from the Lower Pliocene of Perpignan (France). Only an isolated cranium represents this species but shows relationships with *O. mauritanicus* and *O. gaudryi*. The French aardvark was probably myrmecophagous, with a size comparable to that of *O. mauritanicus* (medium to large) and displayed a mosaic of characters both ancestral and modern.

The only Tubulidentata species found in African Pliocene deposits is the second taxa from Chad described recently: *O. djourabensis* Lehmann *et al.*, 2004. This form shows more affinities with modern aardvarks than with Miocene ones (even with the older Chadian species *O. abundulafus*) but also has intermediate features. In particular, the skull of this form is of comparable size to *O. afer*, whereas its teeth are larger and its limbs are proportionally shorter. Thus, *O. djourabensis* was perhaps a slightly less efficient digger than the extant aardvark but was already myrmecophagous. Recent discoveries in Ethiopia (T. White, personal communication) and a revision of Kenyan specimens suggest that this species was also known in East Africa. Except for the extant *O. afer*, *O. djourabensis* would thus be the oldest and only species of Tubulidentata to show a large-scale distribution in Africa.

Other aardvark specimens have been found in different Pliocene sites in south (see Lehmann, 2004) and east Africa (Leakey 1987). These fossil aardvarks are undetermined at the species level, but show affinities with *O. afer* and some unique features. One site, Langebaanweg, yields remains that Pickford (2005) attributed to *O. afer*; this would be the oldest record for the extant species. However, the hypothesis has to be confirmed because this author did not compare the remains with other fossil tubulidentate species.

The Pliocene follows the Messinian Salinity Crisis when the Mediterranean Sea was drained. The climatic changes that followed might have led to the disappearance of the Eurasian Tubulidentata. By the end of the Pliocene, the order was confined to the African continent.

Pleistocene

A single species of Tubulidentata is known from the Pleistocene (1.8 to 0.01 million years). This species—*O. crassidens* MacInnes, 1956—has been found in Kenya and is a large aardvark, matching the size of the largest extant individuals sampled. This form presents the same adaptations than *O. afer* so that Pickford (1975, 2005) suggests that they are synonymous. However, the larger teeth and the unique orientation of the tooth-row in reference to the maxilla are features that have not been found in my study of the intra-specific variations of *O. afer*. Therefore, in agreement with Made (2003) and Lehmann *et al.* (2005), *O. crassidens* is here considered a valid species. Finally, Romer (1938) discovered a sub-fossil aardvark from the Late Pleistocene of Algeria that he attributed to *O. afer*. This specimen could be the oldest known representative of the extant aardvark.

Conclusions and conservation considerations

The Tubulidentata consists of 13 fossil species and 1 extant species. (Note that this species count follows the

classification of Pickford which considers *O. pilgrimi* as a synonym of *O. browni*). These aardvark species are not evenly distributed geographically or temporally (Fig. 5). All Tubulidentata show some degree of adaptation to burrowing and myrmecophagy. According to McNab (1984), once specialised for myrmecophagy, large-bodied eutherians (>1 kg) are very difficult to displace ecologically because such shifting requires a high reproduction rate, itself correlated to a high metabolism. However, myrmecophagous species show generally low body temperatures and low basal metabolic rates.

The last remaining species of this order is thus a highly specialised eutherian living in a very specialised ecological niche. Seiffert (2002) suggests that, after their isolation, Afrotherians must have suffered from competition during the Oligocene and Miocene when land bridges enabled Laurasiatheria to enter Africa, leading them to become highly specialised. However, according to the fossil record, Tubulidentata were already highly specialised 20 million years ago and showed increasing diversity that culminated during the Upper Miocene with at least six species (Fig. 5); the order suffered high taxonomic losses only during the last 5 million years or so.

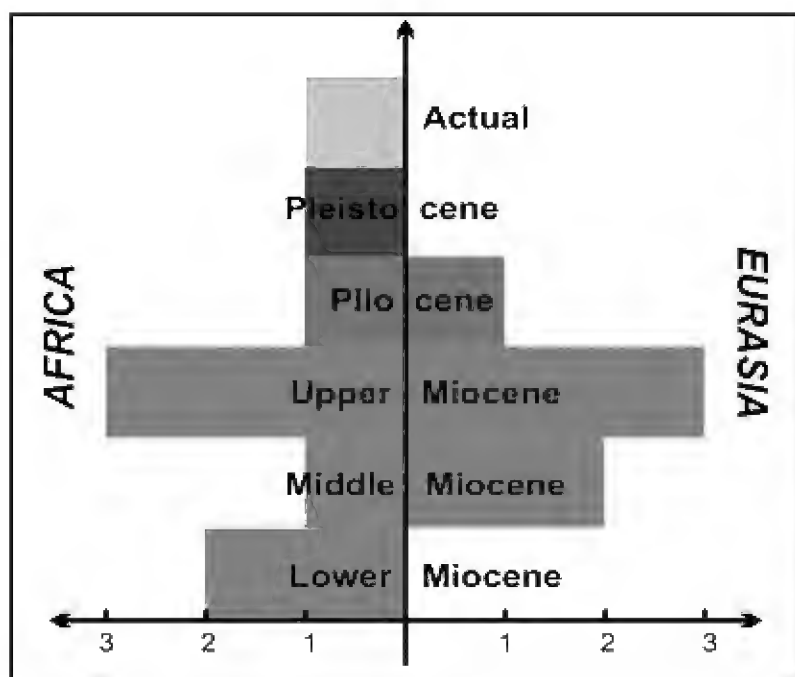


Figure 5: Number of recognised Tubulidentata species over geological time. Note that *O. browni* is known from the Middle and Upper Miocene so is recorded twice in the chart.

My study on the Tubulidentata shows that the fossil biodiversity was much more important than suspected, but suffered relatively recent extinctions. The one remaining species has been on and off the IUCN Red List and is currently considered "least concern". A project now being launched to study the intraspecific variation of extant populations of aardvarks, with the conjunction of morphological, genetic and ecological research, should provide us with a better understanding of the species. This will provide data for future Red List assessments and help us preserve this fascinating and unique Afrotherian.

Acknowledgements

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Article:

Graphical description of the ventral side of a sengi's (*Macroscelides proboscideus*) skull

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Sengis (Macroscelidea), which are hardly known outside the scientific community, have had a "colourful history" (Rathbun 2005) regarding their description and their position within the Eutheria. Decades of morphological descriptions of sengis have led to a few characters, with a polarity for phylogenetic positioning of members of the group (Corbet 1995). This insectivorous taxon within the Afrotheria is clearly characterized by only a few mainly derived characters.

A cranial-morphological set of synapomorphies is needed to approach the questions regarding the taxonomy and phylogeny of the Macroscelidea. Scattered information exists only on selected aspects of the skull of sengis. There are several descriptions of *Elephantulus* species of different ontogenetic stages (e.g. MacPhee 1981) and some publications on Rhynchocyoninae (e.g. Wortman 1920). But, to our knowledge, there is no complete, labelled graphical overview of the ventral aspects of a skull of *Macroscelides proboscideus*. We present such an overview here of a specimen (Figure 1) that came from the breeding colony in our institute (*Museum für Naturkunde Berlin, Institut für Systematische Zoologie*). The specimen (number 1 of the collection of Prof. Zeller) is housed at our museum.

We compare the skull with other sengi specimens, particularly ten analyzed voucher specimens of *Elephantulus intufi* that were collected by two of us (FK, UZ) in Namibia (Permit No. 864/2005) and are currently on loan to us from the National Museum of Namibia (loan No. 5652).

The dry (macerated) skull of this species can be easily identified among any other sengi by its enormously inflated auditory bullae on the dorsal side. A detailed description for an *Elephantulus rozeti* adult specimen can be found in MacPhee (1981).

The ectotympanic (ect) in *M. proboscideus* is largely expanded, in contrast to all *Elephantulus* species. Additionally, it is positioned more laterally than in, for example, *E. intufi*, thus giving room for a longer connection between the ectotympanic and the alisphenoid. The tympanic process of the alisphenoid is much more inflated than in any other sengi; it does not drop off as sharply as in *Elephantulus* but is inflated much more rostrally. Above the very protruding caudal entotympanic (cent) runs the stylohyal. It reaches from the most posterior tip of the caudal entotympanic all the way to the basicochlear fissure (bcf); we found this condition in two specimens of *M. proboscideus* and the ten *E. intufi* specimens. The external acoustic foramen (eam) opens more caudally than in *Elephantulus*.

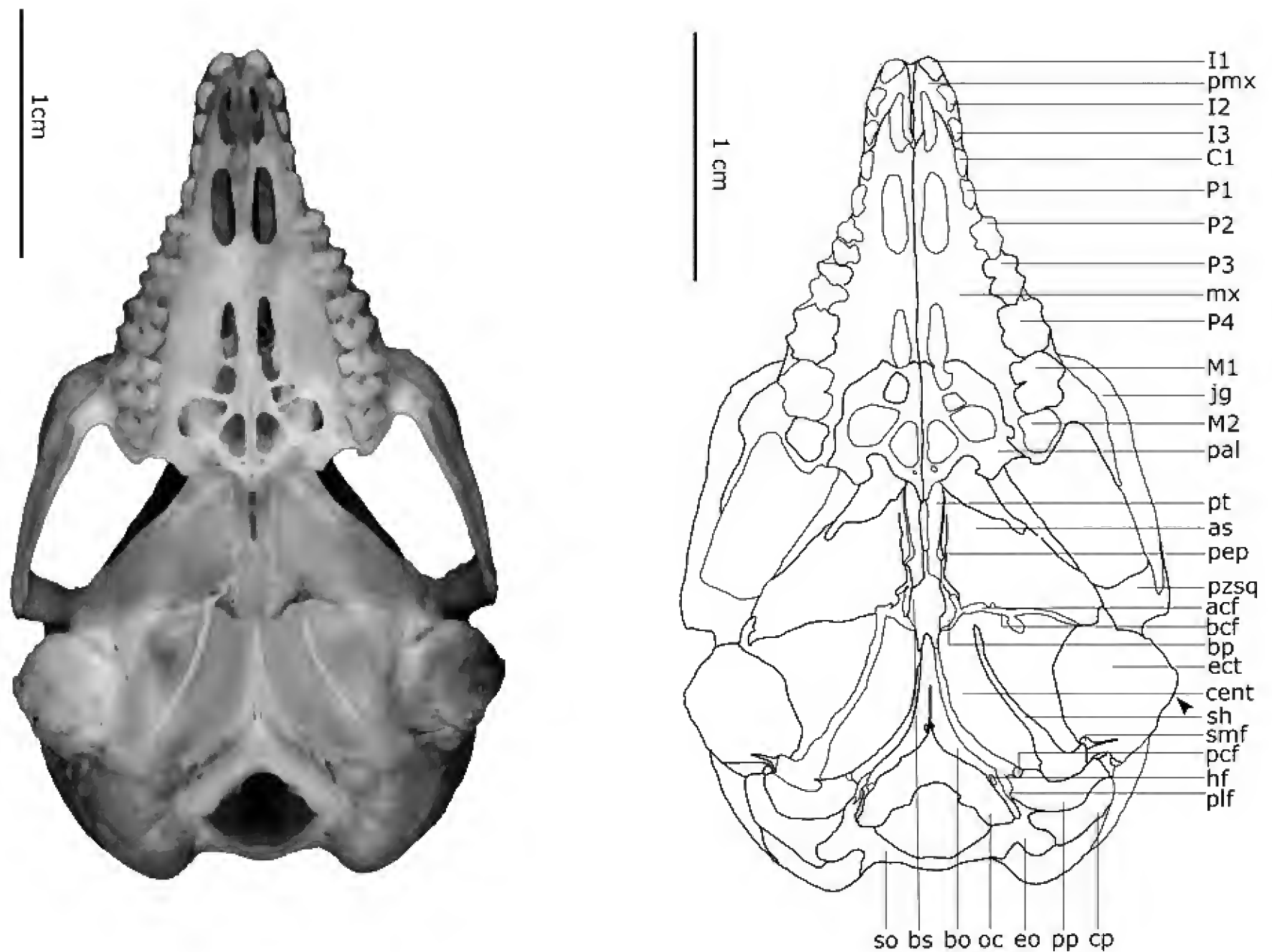


Figure 1: Photo of a skull of *Macroscelides proboscideus* in ventral view, and a line drawing of same skull. Arrow pointing at opening of external acoustic meatus. Abbreviations: acf anterior carotid foramen; as tympanic process of alisphenoid; bcf basicochlear fissure; bo basioccipital; bp tympanic process of basisphenoid; bs basisphenoid; cp caudal tympanic process of petrosal; ect ectotympanic; ent caudal entotympanic; eo exoccipital; hf hypoglossal foramen; jf jugular foramen; mx maxilla; oc occipital condyle; pal palatine; pcf posterior carotid foramen; pep processus ectopterygoideus; pmx praemaxilla; pp petrosal plate; pt pterygoid; pzsq processus zygomaticus squamosi; sh stylohyal; smf stylomastoid foramen; so supraoccipital.

The number and size of foramina in the praemaxilla, the maxilla and the palate are similar in *Elephantulus*, *Petrodromus* and *M. proboscideus*, but there is no comparable fenestration in Rhynchocyoninae. Three pairs of foramina can be easily distinguished on the praemaxilla and the maxilla: Foramina incisiva, Foramina palatina majora, Foramina palatina minora in rostro-caudal order (not labelled). The latter might be fused with the very variable fenestrated palate. The dental formula and description of the teeth is thoroughly analyzed in several publications (e.g. Patterson 1965, Skinner 1990), as there are many characters found for the comparison with fossil taxa.

The extent of variation of cranial arteries is not known until today. Brief and sketchy information on this topic can be found in, for example, van Kampen (1905), Carlsson (1909), van der Klaauw (1931) and Butler (1956) But an overview and comparison, including *Macroscelides proboscideus*, does not exist yet.

This cranial overview can only be regarded as a first step toward a description of all sides of the Macroscelidean skull and a new attempt at a phylogenetic analysis of this order.

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Article:

Observations of black-and-rufous sengis (*Rhynchocyon petersi*) in Diani Forest, Kenya

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The presence of the black-and-rufous sengi (*Rhynchocyon petersi*) in Diani coastal forest, Kenya, is well documented (Kingdon 1974, 1997, 2004, Rathbun 1979). However, the recent development of Diani Beach (near the village of Ukunda, south of Mombasa) as a popular holiday destination has led to some habitat transformation in the area. This note presents observations of the species made in early 2006 and an update on the status of the area.

We visited Diani Beach during the last week of January 2004, the first week of February 2005, and from 25 January to 08 February 2006.

All the hotels and resorts at Diani are aligned between the sea and a tarmac road. Some hotels have kept a few fragments of native vegetation near the ocean but the larger pieces of coastal forest are present on the inland, western side of the road. The forest gives way to scrub in the west, before reaching the main Mombasa-Tanzania road. The forest patch that we surveyed is between the hotels and the Colobus Trust centre. It is about 1 km north to south and 0.5 km wide and includes some scattered construction sites and at least three car tracks crossing from the tarmac road. Some fragments of the coastal forest are still in good condition and local people told us that the sengis have been seen crossing the car tracks from time to time.

We made our observations by foot in the northern part of the forest patch. We made four visits to the forest in 2004, six in 2005 and 13 in 2006, each lasting from 2 to 4 hours. To search for sengis, we either walked slowly along the paths or stood stationary.

We observed sengis only in 2006, with four sightings of maybe 2 different individuals. Twice we saw one animal in the same area when walking on the trail between the forest and the scrubland. It stood still for a few seconds, less than 10 metres away, allowing us to watch and photograph it before running off. The first observation was made around 5 pm and the second around 3.45 pm. Once, the animal was facing us under cover, its nose in the leaf litter. Like the suni (*Neotragus moschatus*), which is quite common in Diani Forest, the sengis were quite tolerant of our presence as long as we kept on the trail.

The two other observations were made while we sat at the foot of a large tree (25 hours altogether were spent at this spot in ten visits). Both times the animals came to within 10 metres of us and remained in view for about 5 minutes, at around 10 am the first time and noon the second time. They left without getting alarmed by our presence, crossing a small trail as they sniffed the air, foraged with their noses in the litter and also rested,

groomed and yawned. Once, one laid down for less than a minute in the leaf litter, with its head and back visible along a small fallen branch among interlacing branches and vines, for less than a minute. On the same occasion, a female suni came by within less than two metres of a sengi and both animals seemed indifferent of the presence of the other.



© F. Moutou

A black-and-rufous sengi in Diani Forest, Kenya.

During our visits we got an idea of the rich biodiversity of Diani coastal forest, which is included in the Eastern Arc and Coastal forests biodiversity hotspot (Kingdon 1990, Mittermeier *et al.* 2000). Visitors usually come to this part of Kenya to snorkel or to see the famous protected areas like Tsavo and Shimba Hills, so few visit Diani forest. From what we saw, the forest remained largely unchanged from January 2004 to February 2006, except for two narrow strips cleared along one of the main tracks to improve security. However, we noticed several small man-made trails crossing the forest that appear to be used for logging.

In January 2006, we were told by people at the Colobus Trust that domestic cats had apparently caught many sengis. Therefore, domestic animals such as dogs and cats, combined with local logging pressure, could pose a threat to the small fragments of coastal forest and the sengis (Rathbun 1998).

Along the seaside, hotels are still being built. However, some fragments of coastal forest are being left intact by resort managers planning to open nature trails as an added tourist attraction. We wrote a booklet in French in 2005 on the fauna and flora of Diani Forest for distribution to some of the resorts. If hotel owners and their visitors are aware of the richness and value of the local wildlife it may help establish incentives to protect the forest and its resident sengi in the long term.

Acknowledgements

We warmly thank the team of the Colobus Trust (<http://www.colobustrust.org>) and the local people we met. We are also grateful to the friends who stood with us for many hours under trees waiting for sengi sightings!

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Afrotheria News

Monogamy in the round-eared sengi under investigation

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Sengis represent an ancient mammalian order and an early radiation within the Eutheria. It is a unique group since all 15 species of sengis are believed to be monogamous. As they are not closely related to any other monogamous mammals, they offer an excellent model to study monogamy.

Male sengis exhibit no direct paternal care and the male and the female of one pair mostly maintain a social distance from each other, resulting in a very weak pair bond. Thus, monogamy in sengis can neither be explained functionally by the benefits of male parental care nor proximally by the occurrence of a pair bond. Instead, recent field studies suggest that mate guarding might be the best explanation for monogamy in sengis. However, mate guarding has not been tested experimentally and incidence of extra-pair paternity are yet not known. Furthermore, the reason for guarding one female instead of several females is not understood. Temporary polygyny has been described for several different sengi species so the question is therefore not only why sengis are monogamous, but also why sengis do not remain polygynous.

In this project for my PhD the evolution of monogamy will be investigated in the round-eared sengi (*Macroscelides proboscideus*). This is one of the smallest sengis, found in arid and semi-arid areas of southern Africa. They are territorial and monogamous mammals. The study will focus on the following aspects:

1. Since only spatial data on the life history of free ranging *M. proboscideus* exists, I will document its social structure and reproductive behaviour, as well as ecological data such as habitat preferences, population structure and density.

2. Mate guarding strategy of males will be tested: Female sengis show a post partum oestrus (e.g. females can become pregnant whilst lactating). Therefore distance of both partners will be determined after the delivery of the pups. In comparison the distance between the male and his mate will be investigated when the female is not receptive to mating.

3. Temporary removal of resident males from their home ranges to establish 1) how long it takes until another male enters the territory, 2) whether neighbouring males entering the territory results in polygyny, or whether the immigrating male changes from floating to monogamy, and 3) whether the neighbouring male can maintain a polygynous situation or if he is soon replaced by an immigrating male.

4. Experiments regarding territorial aggression

5. Paternity analyses

6. Testing the resource holding potential hypothesis: A low variance in fighting ability between sengi males could explain why a polygynous situation switches back to monogamy.

7. Establishment of a captive colony to obtain data on: dominance hierarchy between males and females and territorial aggression; physiology; care giving behaviour towards pups; the preference of females and males towards their partners and strange individuals in regard to the reproductive status of females; mate guarding strategy of males.

The study is being conducted in Goegap Nature Reserve in the Northern Cape of South Africa. In this semi-desert area, the vegetation consists mostly of *Zygophyllum retrofractum* and *Lycium cinerum* shrubs interspersed by sandy patches. The vegetation type is succulent karoo.

My study started in September 2005 and will be completed in August 2008.



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Round-eared sengi (*Macroscelides proboscideus*)

The etymology of “SENGI”

Galen Rathbun and Jonathan Kingdon

Jonathan Kingdon first used SENGI as a common name for elephant-shrews (hyphenated) in “The Kingdon Field Guide to African Mammals” (1997). Since then, we both

have used SENGI in print (e.g. Rathbun & Woodall 2002. A bibliography of elephant-shrews or sengis (Macroscelidea). *Mammal Review* 32:66-70) as well as on websites (Google it!). Increasingly more authors are following suit. Most significantly, the upcoming "Mammals of Africa" will use SENGI.

In Kiswahili-speaking areas of eastern Africa, SENGI means elephant-shrew. Kiswahili names for animals (kongoni, simba, fisi, etc.) often are derived from Bantu tongues (Kizaramo, Kidigo, Kinyamwezi, Kisukuma, etc.), and this seems to be the case for SENGI (e.g. in Kigiriama "sanje" = SENGI).

There are several reasons that SENGI is preferable to elephant-shrew, despite traditional usage. First, SENGIS (Macroscelidea, Macroscelididae) have a very different evolutionary history than true shrews (Insectivora, soricidae) and they share few life history traits. By calling SENGIS a type of shrew, it completely misrepresents their phylogeny and biology to the uninformed. We also believe that it is generally appropriate that local names be used when animals are endemic to a particular region, as SENGIS are to Africa.

What is the correct pronunciation of SENGI? Kiswahili and Bantu languages are phonetic, so the G is hard, as in Galen.

Afrotheria Noticeboard

LAUNCH OF THE 2006 IUCN RED LIST OF THREATENED SPECIES

The launch of the latest update of the IUCN Red List of Threatened Species, the world's most authoritative source of information on the status of plants and animals, will take place on 4 May 2006. The Red List is one of the key tools used to determine the status of the Earth's biodiversity. A major new element since the last update in 2004 is the inclusion of many freshwater and marine species, notably sharks and rays, for the first time. A comprehensive information package is available on the SSC website (<http://www.iucn.org/themes/ssc/>)

For more information please contact Andrew McMullin, Communications Officer, IUCN Species Programme, at Andrew.McMullin@iucn.org

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Rock hyrax (*Procavia capensis*). There are three living genera of hyrax containing five species. In southern Africa hyraxes are called dassies. The rock hyrax is widespread in Africa and extends into the Arabian Peninsula from Lebanon to Saudi Arabia. They are dependent on the presence of suitable refuges in rocky outcrops (kopjes) and mountain cliffs. This species is diurnal and lives in groups of between 2 and 26 individuals. They feed mainly on grass. Litter size is 1-4, with a peak in births coinciding with the rainy season.

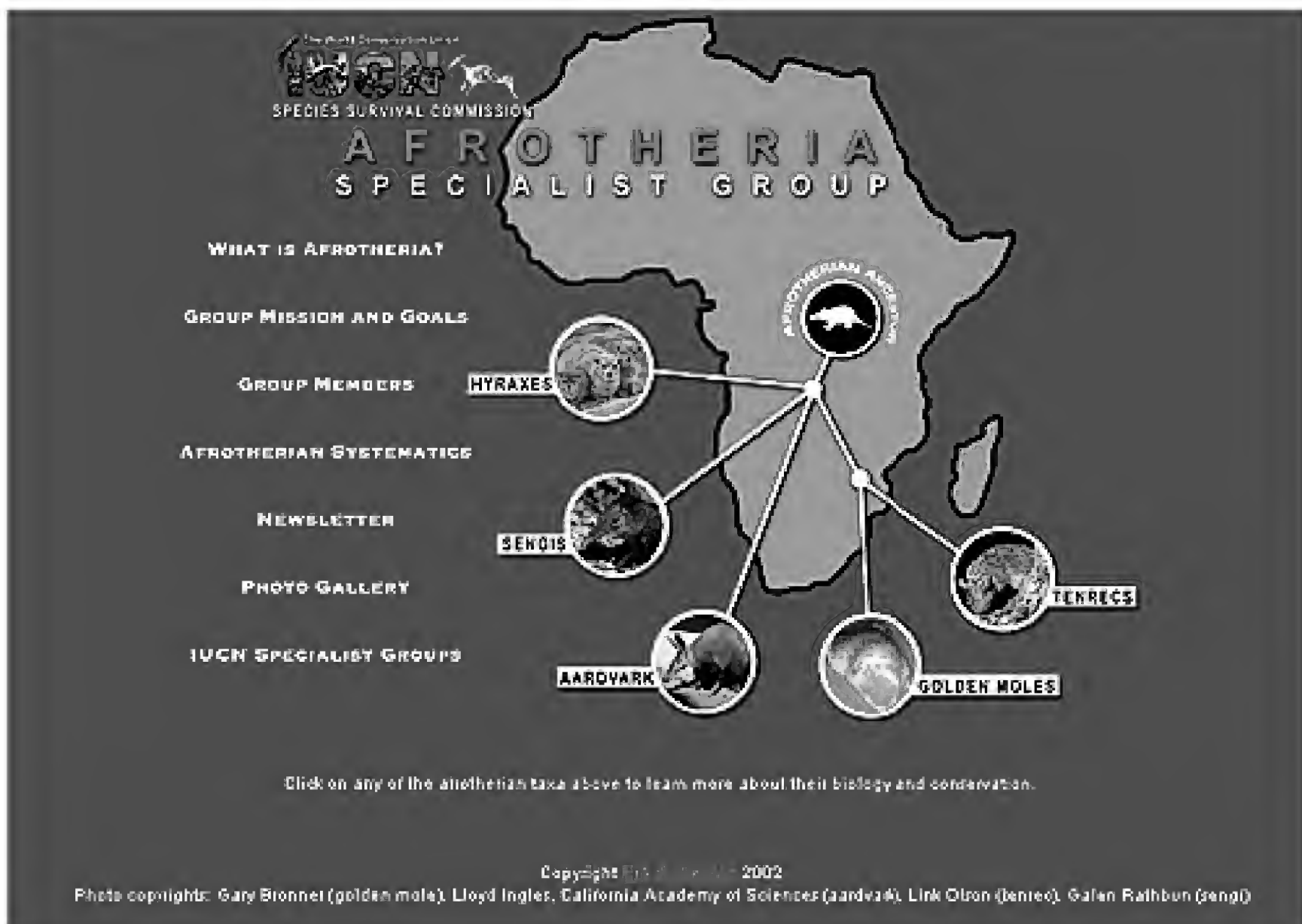
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